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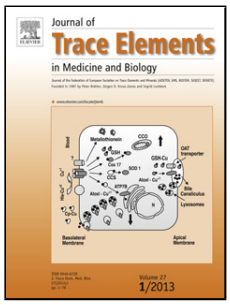

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The toxicological analysis of lead and cadmium in prescription food for special medical purposes and modified milk products for newborns and infants available in Polish pharmacies

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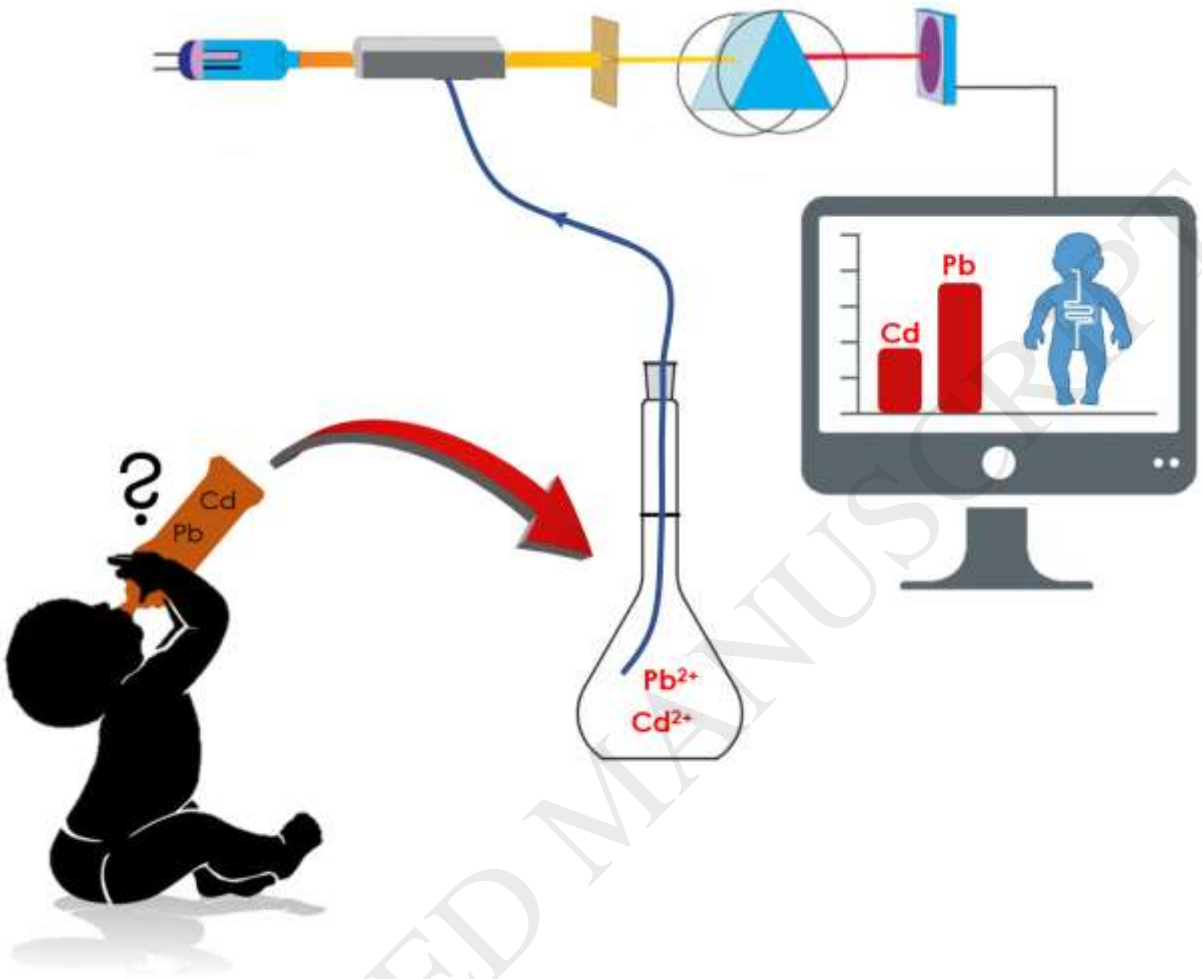
Graphical abstract



Highlights:

- Determination of Pb and Cd in FSMPs and modified milk products for newborns and infants;
- Pb and Cd levels in powdered FSMPs and powdered modified milk products;
- A daily dose of Pb and Cd depending on age (months) and body weight;
- The weekly intake of Pb and Cd in comparison to the provisional tolerable weekly intake (PTWI);

- All analyzed products do not represent a health hazard to the consumer according to Pb and Cd levels.

Abstract:

There is currently a lack of risk assessments around Pb and Cd in prescription food for special medical purposes (FSMPs) and modified milk products available in from pharmacies in Poland. This article describes and evaluates a toxicological analysis of lead and cadmium in prescription FSMPs (n = 6) and modified milk products (n = 6) available in Polish pharmacies. The metals were determined using electrothermal atomisation atomic absorption spectrometry. To make the appropriate risk assessment, we considered (1) the levels of lead and cadmium in a powdered product, (2) the amount of the metals consumed in one portion (single exposure), (3) the daily dose depending on age (months) and body weight and (4) the weekly intake of Pb and Cd in samples in comparison to provisional tolerable weekly intake (PTWI). The results demonstrated that the samples analysed do not represent a health hazard to newborns and infants. This study is important because of the concerns around the complex risk assessment of prescription FSMP's and modified milk products available in Polish pharmacies related to lead and cadmium.

Abbreviations:

AAS – atomic absorption spectrometry, bw – body weight, FCS – food contact substance, FSMPs - food for special medical purposes, PTWI – provisional tolerable weekly intake, WHO – World Health Organisation, RSD – relative standard deviation

Keywords:

heavy metals, lead, cadmium, newborns, infants, atomic absorption spectrometry, food for special medical purposes

1. Introduction

The infancy period is characterised by continuous changes in physiological clearance process and toxicokinetics. Assessment of the health risk associated with dietary heavy metals is important during infancy because the early postnatal period is characterised by rapid growth and development [1]. The newborns and infants are vulnerable to exposure to Pb and Cd due to their immature renal systems and they exhibits narrow tolerance to these elements [2]. Based on the opinion of the Scientific Committee on Food, it is appropriate to reduce the presence of heavy metals such as Cd and Pb in food as much as possible [3, 4].

The bioavailability of Pb ranges from 10% in adults to 40% in children below the age of six months [5]. The uptake of this metal in the neonatal period depends on the bioavailability of this metal from milk diets. Pb is absorbed, and the amount that is not excreted is rendered inactive through storage. This metal can be partially available (e.g., bone-Pb) or mostly unavailable in chemical forms, such as metallothioneins [6] in the liver and kidneys [7]. The presence of this element in blood is of significance – increased Pb levels in the blood may impair erythropoiesis by inhibiting protoporphyrin synthesis, and impairing Fe absorption thus increasing the risk of anaemia [8]. This is especially important in the infancy period – because of the intensity of the production of red blood cells at this time. The toxicity of Pb to the central nervous system in the initial stages of life is also well-known. This metal can also cause subtle effects on the children's renal and dopaminergic systems - in particular, renal hyperfiltration appears in an early response to lead [9].

Cadmium is also called "*new lead*" due to its prevalence in the environment and its ease of

entry into biological systems [12]. About 50% of the human average dietary intake originates from cereal products. This is of special concern to infants and young children due to the fact, that they are introduced to these products at an early age. The formulae are usually prepared by adding drinking water, which could further increase the intake of this element [13,14].

Exposure to Pb and Cd is of significance to newborns and infants that are not breastfed. It can occur from prescription FSMP's and modified milk products dedicated to newborns and infants. FSMPs are derived mostly from animals or plants and are usually milk-based or soy-based formulations. Milk formulas are usually recommended when there are problems with breastfeeding and infant milk formulas serve as substitutes for human milk [15]. The nutrients levels in these kinds of products are usually modelled on the composition of human milk and one goal of the improvement of infant formulae is to make them even more similar to human milk [16]. Milk formulas for healthy children who cannot be breastfed can be divided into two groups [17]: initial ones, i.e. *initial (first) milk formula* - from birth to 6 months, and the s*ubsequent (follow-on) milk formula* - used from the age of 7 months to one year .

The FSMP's and modified milk products derived from plants (source of metals impurities/contaminations) are of great concern. It should be noted that Food Contact Substance (FCS's) and/or impurities from the FCSs may migrate into food at very low levels [18-19].

Safety assessment and risk assessment studies of metals impurities related to FSMPs and modified milk products are important from nutritional and toxicological points of view. Studies related to FSMPs are important because these products are usually issued on a pharmacy prescription, and these kinds of samples are not commonly toxicologically analysed. Futher justification for undertaking these kinds of studies is the fact that very often the existing data in the literature are frequently questionable because of (1) insufficient control of metals contaminations, (2) lack of a sufficient validation step, and (3) inadequate sensitivity of the analytical techniques applied.

2. Materials and methods

2.1. Reagents

The water for the experimental work was demineralised water (Millipore). Nitric acid (65%) was of spectroscopic grade (Merck SupraPur, Darmstadt, Germany). Standard solutions of Cd (Cd standard solution traceable to SRM from NIST – $Cd(NO_3)_2$ in 0.5 mol·L^{-1} HNO_3, 1000 mg·L^{-1} Cd CertiPUR®, catalog product: 1.19777.0500) and Pb (Pb standard solution traceable to SRM from NIST– $Pb(NO_3)_2$ in 0.5 mol·L^{-1} HNO_3, 1000 mg·L^{-1} Cd CertiPUR®, catalog product: 19776.0500) were prepared by dilution of certified standard solutions, 1000 μg·L^{-1} MERC of corresponding metal ions.

The certified reference material was Corn Flour (INCT-CF-3, the Institute of Nuclear Chemistry and Technology Warsaw, Poland). Detailed data for reference materials are presented in supporting information (see Table S1).

2.2. Samples

Based on the results of opinions of paediatricians in Kraków and a questionnaire from fifteen young parents (27 – 36 years old) from Niepołomice (Poland), twelve different pharmaceutical products were analysed. The samples investigated samples (in triplicate) were FSMP's (A-C) and modified milk products (D-F) for babies in the infancy period. The samples were initial milk formulas (numbered as "1"; 0 – 6 months) and subsequent milk formulas from the same manufacturer (numbered as "2"; 7-12 months). The coding system of samples is given in Table 1. Prescription FSMPs and modified milk products were obtained from pharmacies in Kraków or Niepołomice (Poland).

2.3. Sampling

A representative sample from the original packaging of the product was collected for the analyses. To avoid potential metal contamination, the sampling step was carried out using a single plastic spoon. The samples were stored at a room temperature in sterilised disposable plastic containers purchased from pharmacies originally intended for urine analyses. The containers were closed with a plastic twist. Each sample was named (A-F) and numbered 1. or 2. as described earlier.

2.4. Sample preparation for heavy metals analysis

Prior to the measurements, samples were dried in an oven at 70 ° C in a weighed ceramic crucible for 48 h to constant weight. The moisture content was calculated to be about 3%.

Each sample, approximately 0.3 g was subjected to microwave-assisted wet digestion with 5.0 mL nitric acid, HNO_3. Following the microwave digestion the sample was subjected to a multi stage digestion program over two hours (see supporting information - Table S2).

After cooling, the resulting solutions were diluted up to 20 mL in volumetric flasks with demineralised water and kept as stock solutions at room temperature (20-25 °C) until analysis (for a few days).

2.5. Apparatus

A microwave oven CEM MDS 2000 (CEM USA), programmable for time and microwave power was used for acid digestion of samples (see Table S2. in section *2.4. Sample preparation for heavy metals analysis*).

All determinations were performed using a Perkin-Elmer 5100 ZL (CT, USA) atomic absorption spectrometer with Zeeman background correction. Cd and Pb were determined using electrothermal atomisation. Pyrolytically coated graphite tubes with L'vovs platforms were applied. Measurements were made with a Cd hollow-cathode lamp of 4 mA, with a slit width

set of 0.7 nm. For Pb determination, a Pb hollow-cathode lamp of 10 mA with a slit width of 0.7 nm was used. The instrumental parameters are presented in supporting information (see Table S3).

Argon was used as the purge gas. The time-temperature program of the graphite furnace for analyses of Pb and Cd is shown in supporting information (see Table S4 and Table S5).

2.6. Heavy metal analysis procedure

All instrumental parameters are presented in earlier sections. The basic simplified workflow of analytical procedure steps is illustrated in Fig. 1.

2.7. Analytical calibration approach and quality control

The linear range of the calibration function reached from the detection limit up 0.0; 0.5; 1.0; 2.0 $\mu g \cdot L^{-1}$ for Cd and 0.0; 1.0; 2.0; 5.0; 10.0 Pb $\mu g \cdot L^{-1}$, respectively. The data gave a correlation coefficient (R) of 0.998 for Pb and 0.998 for Cd; the values of R were good indicators of the linearity of the AAS instrument for precision and accuracy of results [22, 23].

The limit of detection (LOD) was defined as (3 SD)/*a*, where SD is the standard deviation corresponding to 10 blank injections and "*a*" is the slope of the calibration curve, obtained for each heavy metal. The LODs were calculated for Pb 0.45 $\mu g \cdot L^{-1}$ and Cd 0.15 $\mu g \cdot L^{-1}$, respectively. For the quantitative measurement of elements, LOQ (limit of quantification) is also necessary. LOQ was defined as (10 SD)/*a*, where SD is the standard deviation corresponding to 10 blank injections and "*a*" is the slope of the calibration curve, obtained for each heavy metal. The LOQs were calculated for Pb 0.91 $\mu g \cdot L^{-1}$ and Cd 0.30 $\mu g \cdot L^{-1}$.

The recoveries obtained were appropriate: 97.0 % for Pb and 96.5 % for Cd. The recoveries were calculated as the quotient of the determined level and the known amount of the determined element expressed as a percentage according to analysed samples.

To assess possible contamination during the sample preparation and analytical calibration step, blank samples of ultrapure water were analysed using the same procedure as for the samples.

The quality control and validation of applied methodology are confirmed by previously described studies using the same methodology and apparatus [20-21].

2.8. Statistical approach

All chemical analyses were performed triplicate. The mean and relative standard deviation (%RSD) as a percentage were calculated. We used RSD because it reflects variation and repeatability of the measurements in an easier way than the standard deviation (SD). Data were analysed using Microsoft Office Excel 2016 for Windows.

3. Results

The Cd and Pb levels in the samples can be presented using four approaches (1) raw results (dried basis, $\mu g \cdot kg^{-1}$), (2) including dilution in the finished product (the one-time administration), (3) taken daily dose and (4) tolerable weekly intake. This quadruple approach is justified from a risk assessment point of view since:

- It is possible to obtain information on the concentration of heavy metals in a concentrated product - the ability to check the fulfilment of standards,
- The actual amount of metal consumed in one portion can be measured (single exposure),
- Daily dose, depending on age (months) and body weight,
- Provisional tolerable weekly intake (PTWI) can be measured.

3.1. "Raw" results (heavy metal per kg of dried mass)

The "raw" results for the samples are given in Table 2, as μg heavy metal per kg of dried

mass. The products are divided into groups related to the recommended age of product use. Results are given as an average of several products with the relative standard deviation (%RSD). It should be noted that the %RSD values result from the fact that the concentrations of heavy metals are at ppb levels.

For Cd, the samples of initial milk formulas (0 – 6 months) in most cases (except two samples) are characterised by higher levels of this element than the corresponding subsequent milk formulas (6-12 months). A closer inspection of the results shows that higher levels of Cd in the initial milk formulas are due to the levels observed in the FSMP's.

The Pb levels in the samples of initial milk formulas (0 – 6 months) and in the corresponding subsequent milk formulas (6-12 months) are very variable and no discernable trends are apparent.

3.2. The one-time administration of applied FSMPs and modified milk products

It should be noted that while the Cd and Pb levels in the dry mass of the starting product are very important due to the product safety assessment, the most valuable information from the risk assessment point of view is the actual amount of these heavy metals in the single portion of milk once constitued, i.e. concentration of heavy metals in the one-time administration of applied FSMPs and modified milks. For this purpose, it is necessary to determine the concentration of lead and cadmium in the amount of milk corresponding to one portion dissolved in a precisely defined volume of water specified by the producer taking into account that water controls contain negligible levels of the metals. To determine the concentration of heavy metals in one portion of finished milk, the appropriate calculations have been carried based on:

- raw results in a dry product (heavy metal per kg of dried mass);
- the proportions of making milk for each product - the amount of dry product (the amount

of dry product contained in the spoon attached to the package) and the corresponding volume of water.

The results of the one-time administration of applied FSMPs and modified milk products for analysed samples (triplicates) are given in Table 3., as μg/L of milk.

3.3. Daily dose, depending on age (months) and body weight

The diet for babies in the infancy period is very individual and depends, to an extent, on healthcare professional advise. However, all manufacturers put the information on the packaging as a guide for the correct amounts of cool boiled water and milk in powder form to use. It should be emphasised that the frequency of feeding depends on the age (months) and the body weight of the newborn or infant. Hence, the daily doses were calculated based on the information in Table 4.

3.4. The weekly intake of Cd and Pb in analysed samples related to provisional tolerable weekly intake (PTWI)

The provisional tolerable weekly intake (PTWI) is the maximum amount of a contaminant to which a person can be exposed per week over a lifetime without an unacceptable risk of health effects [22]. The level is provisional since is subject to review when new information becomes available. The values of the weekly intake of Cd and Pb in analysed samples were calculated by multiplying daily consumption seven times – Table 5.

4. Discussion

4.1. "Raw" results (heavy metal per kg of dried mass)

There is no doubt that prescription FSMPs and modified milk products contribute significantly to Cd and Pb exposure of newborns, infants and young children. However, it is difficult to compare our results to others because, to the best of our knowledge, there is a dearth of appropriate scientific articles and other sources (regulations, monographs and etc.) about levels of lead and cadmium in FSMPs. Based on our best knowledge, only Kazi et al. [23] described Cd and Pb levels in infant milk-based formulae (IMF) available in Pakistan. The mean level of Cd in IMF was 7.86 ± 2.68 $\mu g \cdot kg^{-1}$ and mean level of Pb in IMF was 64.2 ± 9.93 $\mu g \cdot kg^{-1}$. In our studies, the mean levels 10.59 ± 0.96 $\mu g \cdot kg^{-1}$ and 17.29 ± 3.70 $\mu g \cdot kg^{-1}$ for Cd and Pb respectively. While there is a similarity in Cd levels, the results for Pb are very different. However, this kind of comparisons would be more reliable and justified if (1) there would be more samples and (2) samples would come from the same geographical region (Pakistan is in Asia and Poland is in Europe). Nevertheless, the obtained "raw" results do not differ drastically – we obtained a similar order of magnitude.

4.2. The one-time administration of applied FSMPs and modified milk products

The results of the one-time administration of investigated FSMPs and modified milk products for the samples are given in Table 3., as $\mu g \cdot L^{-1}$ of milk. Based on the Commission Regulation (EC, No 488/2014 [24]), the maximum level of Cd has been established in liquid formulae manufactured from cows' milk proteins or protein hydrolysates as 0.005 mg/kg wet weight, i.e., 5 $\mu g \cdot kg^{-1}$ wet weight (approximately 5 µg/L). In turn, the European Commission Regulation (EC, No 1881/2006 [25]) setting the maximum levels for Pb in infant formulae and follow-on formulae as 0.020 mg/kg wet weight, i.e. 20 $\mu g \cdot kg^{-1}$ wet weight (approximately 20 µg/L). Measured levels of Cd and Pb in liquid formulae are not the only levels of these elements in a dry product dissolved in water, but also the presence of Pb in tap water. Based on use of tap water for sample preparation (see the LOD and LOQ values in *2.7. Analytical calibration*

approach and quality control) the products contained Cd or Pb in amounts that do not apparently represent a health hazard to the consumer. Based on our best knowledge, there is a lack of available similar studies in literature related to the one-time administration of analysed samples, hence there is no possibility to compare results with other studies.

4.3. Daily dose, depending on age (months) and body weight

Since the European Food Safety Authority (EFSA) excluded Cd from the safety assessment of certain food products that could be linked to a specific commodity (e.g. infant formula) [26], there it is not possible to compare our results (Table 4.) with EFSA recommendations or other references. However, the results obtained may be value to other researchers and are necessary to calculate the weekly intake.

EFSA estimated exposures for infant's formula and reported average exposures of lead from 0.27 to 0.63 μg/kg bw per day, based on lower-bound and upper-bound assumptions, respectively [3]. For infants with high dietary exposure, Pb exposures ranged from 0.40 to 0.94 μg/kg bw per day [3]. Based on our results (Table 4.) it is possible to compare daily dose, depending on age and body weight. The results show that only sample B and C are characterised by higher values of exposures based on upper-bound assumptions (values above 0.63 μg/ kg bw/day). However, since the limits are only exceeded by a small amount not exceeding Pb exposures for infants with high dietary exposure, none of the investigated samples represents a health hazard to the consumer.

4.4. The weekly intake of Cd and Pb in analysed samples related to provisional tolerable weekly intake

The values of PTWI are established usually by *Food and Agriculture Organization/World Health Organization Joint Expert Committee on Food Additives* (JECFA) based on

experimental work available in the literature.

The available data indicated that most individuals had intake levels of Cd below the relevant PTWI (7 μg/kg bw/week). Several international bodies have recognised that the margin between this PTWI and the actual weekly intake of cadmium by the general population is small and, in some populations, may be non-existent. It should be mentioned that due to the different consumption patterns and lower body weights, infants and children are considered as a separate group in risk assessments. Higher gastrointestinal absorption in combination with the consumption of infant formula composed of ingredients with higher cadmium content than breast milk, may lead to increased internal cadmium exposure of these infants. However, due to the limited number of studies about the level of this metal in literature, JECFA has not established the value of PTWI dedicated to infancy period. Ursinyova et al. [27] analysed eight samples of infant formula related to Cd intake levels. All breast milk samples were drawn from non-smoking mothers without occupational exposure to this heavy metal. Dietary exposure estimates were based on a mean infant body weight of 5 kg and a daily intake of milk of 0.8 kg. The median concentrations of cadmium in the samples were 0.5 μg/kg for breast milk and 0.6 μg/kg for infant formulae resulting in slightly higher intakes from infant formulae compared to breast milk (0.56 μg/kg bw per week from breastfeeding and 0.67 μg/kg bw per week from infant formulas). Our results (Table 5.) show that values are not exceeded than recommendations (PTWI of 7 μg/kg bw/week to all age groups).

The PTWI of Pb was established by the JECFA as 25 μg/kg bw for adults, infants and young children [3]. Hence, our results (Table 4.) are below the recommended PTWI. None of the investigated samples represents a health hazard to consumers.

5. Conclusions

The comparison of the obtained “raw” results for modified milk products with the literature

data indicates that while there is convergence in the results for Cd, the results for Pb are not comparable. The data from the "*raw*" results can be valuable for other researchers and were necessary for further calculations. The ready to use liquid formula's products contained Cd or Pb in amounts that could not represent a health hazard to the consumer (all results are below 5 $\mu g \cdot kg^{-1}$ for the Cd and below 25 $\mu g \cdot kg^{-1}$ for Pb).

Weekly intake of Cd in the samples do not exceeded the PTWI of 7 µg/kg bw to all age groups/week. All of the samples investigated do not represent a health hazard to the consumer in respect of PTWI of Pb.

Our results show that all of the analysed prescription FSMPs and modified milk products available in Polish pharmacies do not represent a health hazard to the consumer in relation to Pb and Cd levels. However, these products should be monitored for the presence of other toxic metals which were not analysed (e. g. mercury, arsenic, nickel, chromium). It would be valuable to carry out a broader study considering other FSMPs and modified milk products from, for example other countries.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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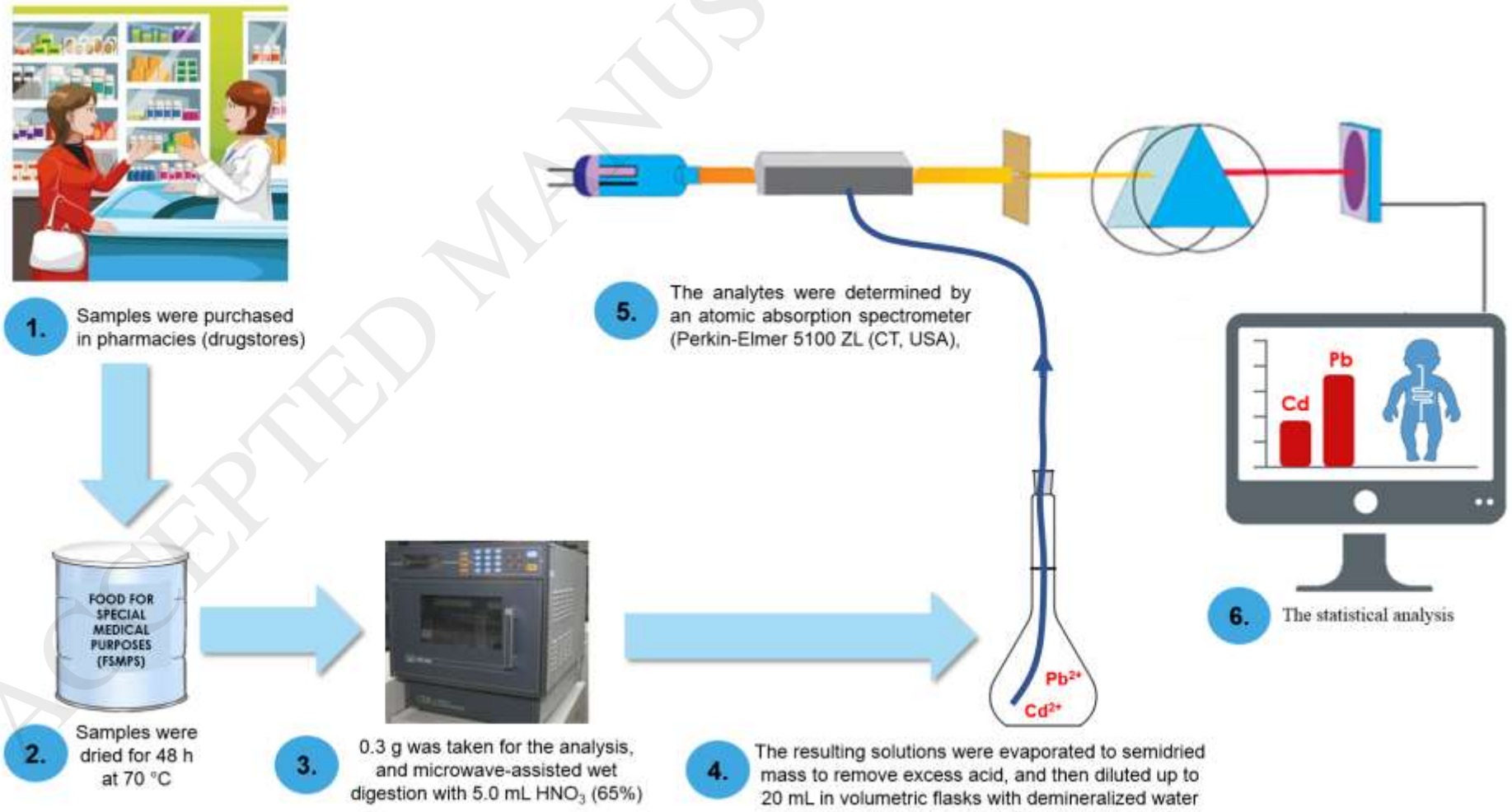

Fig. 1. The basic simplified workflow – analytical procedure steps of determination of Pb and Cd by the ET-AAS.

Table 1. The coding system of samples (n = 12): FSMPs (A–C) and modified milk products (D–F).

Sample		
No.	Type	Code
1.	prescription FSMPs	A 1
2.		A 2
3.		B 1
4.		B2
5.		C 1
6.		C 2
7.	modified milk product	D 1
8.		D 2
9.		E 1
10.		E 2
11.		F 1
12.		F 2

Abbreviations: "1" – initial milk formulas (0 – 6 months); "2" – the subsequent milk formulas (7-12 months).

Table 2. The concentration of Cd and Pb in analysed samples (dried basis, $\mu g \cdot kg^{-1}$); FSMPs – food for special medical purposes; %RSD – relative standard deviation.

Sample			Cd concentration. $\mu g \cdot kg^{-1}$		Pb concentration. $\mu g \cdot kg^{-1}$	
No.	Type	Code	Mean	%RSD	Mean	%RSD
1.	prescription FSMPs	A 1	10.15	2.15	13.06	3.09
2.		A 2	11.70	7.00	16.73	0.60
3.		B 1	11.63	0.70	23.99	12.9
4.		B2	8.52	1.80	17.58	2.60
5.		C 1	10.11	3.00	23.99	2.54
6.		C 2	11.01	4.60	13.20	1.67
7.	modified milk product	D 1	10.26	8.50	11.20	1.17
8.		D 2	9.33	5.70	18.95	3.44
9.		E 1	12.14	1.11	18.71	1.49
10.		E 2	10.74	3.1	15.37	1.16
11.		F 1	11.06	9.65	17.51	1.89
12.		F 2	10.03	8.02	22.06	8.50

Table 3. The concentrations of Cd and Pb in analysed samples including the one-time administration (μg·L^{-1} of milk); FSMPs - food for special medical purposes; %RSD – relative standard deviation.

Sample			Cd concentration, μg·L^{-1} of milk		Pb concentration, μg·L^{-1} of milk	
No.	Type	Code	Mean	%RSD	Mean	%RSD
1.	prescription FSMP	A 1	1.66	2.15	2.13	3.09
2.		A 2	1.91	7.00	2.73	0.60
3.		B 1	1.74	0.70	3.60	12.9
4.		B2	1.28	1.80	2.64	2.60
5.		C 1	1.52	3.00	3.60	2.54
6.		C 2	1.65	4.60	1.98	1.67
7.	modified milk product	D 1	1.47	8.50	1.61	1.17
8.		D 2	1.34	5.70	2.72	3.44
9.		E 1	1.66	1.11	2.56	1.49
10.		E 2	1.47	3.1	2.10	1.16
11.		F 1	1.73	9.65	2.74	1.89
12.		F 2	1.57	8.02	3.46	8.50

Table 4. A daily dose of Cd and Pb in analysed samples (µg/kg bw/day).

	age	approximate body weight [kg]	samples																	
			prescription FSMPs									modified milk products								
			A			B			C			D			E			F		
results for Cd	0 – 2 weeks	< 3.0 – 3.5	1	0.331	0.284	1	0.3488	0.299	1	0.303	0.260	1	0.2942	0.252	1	0.332	0.284	1	0,346	0.297
	2 – 4 weeks	3.5 – 4.0		0.339	0.296		0.357	0.311		0.310	0.271		0.300	0.262		0.339	0.297		0.354	0.310
	4 – 8 weeks	4.0 – 5.0		0.352	0.282		0.3706	0.230		0.322	0.257		0.313	0.250		0.352	0.282		0.368	0.294
	8 – 16 weeks	5.0 – 6.5		0.299	0.230		0.314	0.241		0.279	0.210		0.649	0.204		0.299	0.230		0.312	0.240
	4 – 6 months	> 6.5		0.235			0.247			0.215			0.208			0.235			0.245	
	6 – 12 months	> 6.5	2	0.169			0.113		2	0.146		2	0.118		2	0.130		2	0.130	
	age	approximate body weight [kg]	prescription FSMPs									modified milk products								
			A			B			C			D			E			F		
results for Pb	0 – 2 weeks	<3.0 – 3.5	1	0.426	0.365	1	0.720	0.617	1	0.720	0.617	1	0.321	0.275	1	0.512	0.439	1	0.549	0.470
	2 – 4 weeks	3.5 – 4.0		0.436	0.381		0.735	0.643		0.735	0.643		0.328	0.287		0.523	0.457		0.560	0.490
	4 – 8 weeks	4.0 – 5.0		0.453	0.362		0.765	0.612		0.765	0.612		0.341	0.273		0.544	0.435		0.583	0.466
	8 – 16 weeks	5.0 – 6.5		0.384	0.295		0.648	0.498		0.648	0.498		0.289	0.222		0.460	0.354		0.494	0.380
	4 – 6 months	>6.5		0.302			0.280			0.509			0.227			0.362			0.388	
	6 – 12 months	>6.5	2	0.242		2	0.233		2	0.175		2	0.240		2	0.186		2	0.306	

Applied acronyms and description of numbers: bw – body weight., FSMPs - food for special medical purposes; 1 – initial milk formulas (0 – 6 months); 2 – subsequent milk formulas (6-12 months).

Table 5. The weekly intake of Cd and Pb in analysed samples (µg/kg bw/week)

age	approximate body weight [kg]	samples																	
		prescription FSMPs									modified milk products								
		A			B			C			D			E			F		
0 – 2 weeks	< 3.0 – 3.5	1	2.317	1.988	1	2.442	2.093	1	2.122	1.819	1	2.059	1.765	1	2.323	1.991	1	2.425	2.078
2 – 4 weeks	3.5 – 4.0		2.373	2.072		2.494	2.182		2.168	1.897		2.104	1.841		2.372	2.076		2.477	2.167
4 – 8 weeks	4.0 – 5.0		2.464	1.974		2.594	2.075		2.255	1.804		2.188	1.750		2.468	1.974		2.576	2.061
8 – 16 weeks	5.0 – 6.5		2.093	1.610		2.197	1.690		1.910	1.469		1.853	1.426		2.090	1.608		2.182	1.679
4 – 6 months	> 6.5		1.645			1.728			1.502			1.457			1.644			1.716	
6 – 12 months	> 6.5	2	1.183			0.791		2	1.022		2	0.829		2	0.909		2	0.909	
age	approximate body weight [kg]	prescription FSMPs									modified milk products								
		A			B			C			D			E			F		
0 – 2 weeks	<3.0 – 3.5	1	2.985	2.558	1	5.039	4.319	1	5.039	4.319	1	2.247	1.926	1	3.581	3.070	1	3.840	3.292
2 – 4 weeks	3.5 – 4.0		3.049	2.668		5.147	4.503		5.147	4.503		2.295	2.008		3.658	3.201		3.922	3.432
4 – 8 weeks	4.0 – 5.0		3.171	2.537		5.354	4.283		5.354	4.283		2.387	1.910		3.805	3.044		4.080	3.264
8 – 16 weeks	5.0 – 6.5		2.686	2.066		4.535	3.488		4.535	3.488		2.022	1.556		3.223	2.479		3.456	2.659
4 – 6 months	>6.5		2.112			1.962			3.566			1.590			2.534			2.718	
6 – 12 months	>6.5	2	1.692		2	1.633		2	1.226		2	1.681		2	1.300		2	2.140	

Applied acronyms and description of numbers: bw – body weight, FSMPs - food for special medical purposes; 1 – initial milk formulas (0 – 6 months); 2 – subsequent milk formulas (6-12 months).